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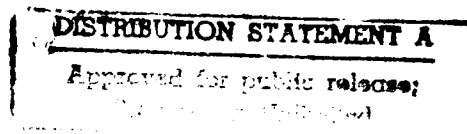
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COMBAT MODELING AND THE AIRLAND BATTLE - PAST, PRESENT, AND FUTURE

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COMBAT MODELING AND THE AIRLAND BATTLE - PAST, PRESENT, AND FUTURE

ABSTRACT

Many theater-level combat simulation models were developed with a linear NATO-Warsaw Pact conflict in mind. Conversely, emerging AirLand Battle-Future doctrine stresses smaller forces on nonlinear battlefields. This paper describes how an existing theater-level model, the Concepts Evaluation Model (CEM), models many AirLand Battle and AirLand Battle-Future tenets with examples from Operation Desert Storm Campaign Analyses.

THE METHODOLOGY MAY BE APPLIED TO any ground combat simulation model with properties similar to CEM (CEM is briefly described in Chapter 2). Recommended application would specifically include force on force theater-level combat models.

MAJOR ASSUMPTIONS

(1) AirLand Battle-Future (or AirLand Warfare or AirLand Operations) will be accepted by the US Army as its doctrine.

(2) Most deterministic theater-level models are similar enough in their properties to allow application of some or all of the concepts embodied within this paper.

(3) Computer simulations will continue to provide important insights into combat capabilities of forces.

MAJOR LIMITATIONS

(1) Applications and methodologies used within apply to CEM. Dissimilarities of other combat simulations may preclude adaptations of any or all of these insights.

(2) The applications and methodologies described here were developed over an extremely short time period in order to provide timely, realistic simulations of critical combat contingency plans. Refinement or replacement of any or all of these methodologies after further research and development is possible.

RESEARCH PAPER DATA

Audience: Analysts familiar with the basic theories, assumptions, and challenges of combat simulation models. It is not intended for a lay audience.

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CHAPTER 1

BACKGROUND

1-1. INTRODUCTION

a. World in Flux

As the dust from the Berlin Wall's demolition settled over Europe, and the hue and cry for a peace dividend rose in the halls of Congress, US policy-makers struggled to define the next "threat." Emerging doctrine envisioned smaller forces operating on a nonlinear battlefield. Low intensity conflict (LIC) seemed to be the most likely contingency the nation would face.

The analytical subcommunity of combat simulators felt that same rumbling as the Wall fell. Significant challenges faced a group with methodologies steeped in 40 years of simulating NATO's defense of free Europe. Are the combat models which portrayed mechanized warfare a thing of the past? Do we need new models? Will we need *any* models? As policymakers struggled to define the threat, the analytical community tried to envision the size, the weapons, and the combat potential this threat might have. Some saw the drug cartels of the Third World as the next nemesis. Others claimed that the Soviet bear was not in its death throes, but only playing possum. But not many saw the Phoenix forming in the sciroccos of the Iraqi desert, personified by Saddam Hussein, and embodied by the fourth largest armed forces in the world.

b. New World Order

As the new world order emerges from the rended garment once known as the Iron Curtain and the tumultuous sands of the Middle East, the challenges facing analysts are tremendous. Desert Storm played an important role in redefining the types of conflicts anticipate in the future. Mid-intensity conflicts are now seen to be about as likely as LICs. (See Figure 1-1.) The "catch-22" for military analysts revolves around the shrinking defense budget. With smaller armed forces, new doctrine must necessarily develop. New doctrine must be modeled to provide decisionmakers guidance on the most effective and efficient way to spend the ever-dwindling defense dollars. Fewer dollars for weapons will almost certainly mean even fewer dollars for the analytical community. Yet the analytical community must model the new doctrine while absorbing funding cuts.

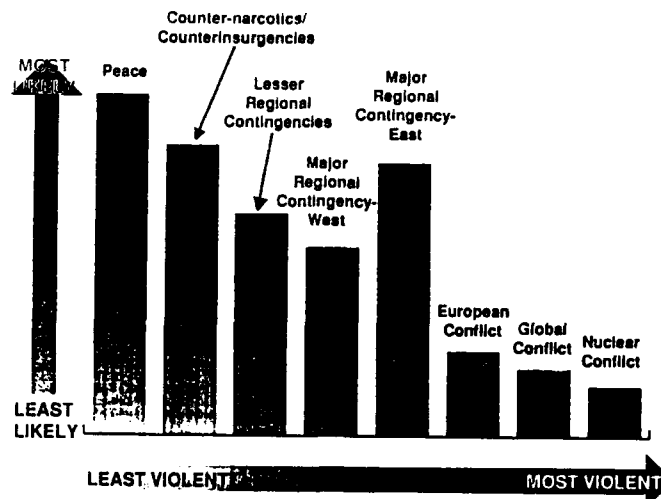


Figure 1-1. Likelihood of Future Conflict
(Joint Military Net Assessment, 1991)

c. **Motivation.** Clearer understanding of new doctrine is essential for the military analyst. AirLand Battle doctrine, centered around the defense of Europe, is giving way to AirLand Battle-Future. Nonlinear warfare with the ultimate objective of destruction of the enemy is the foundation for future modeling initiatives.

d. **Focus.** From an analyst's standpoint, this is not a technical paper. Indeed, many of the innovations used in modeling Desert Storm can be easily understood by new analysts who have had only a brief introduction to combat simulations. The intent of this paper is to outline the challenges that AirLand Battle-Future doctrine presents the combat simulation analyst and to address how those challenges were answered by the analysts at the Concepts Analysis Agency as they modeled Desert Storm.

1-2. **MODELING DESERT STORM.** On August 13, Forces Directorate, CAA, began work on Contingency Operations in Southwest Asia (COSWA) in response to the Persian Gulf crisis. The Concepts Evaluation Model (CEM) was used for this effort. This followed the Agency's initial analysis efforts using the interactive Contingency Force Analysis Wargame (CFAW) Model to provide combat simulation analysis to the Deputy Chief of Staff for Operations and Plans (DCSOPS) and Joint Staff. Although time from input data collection to final results has been up to a year for studies using theater-level simulations, the first results from the COSWA series of quick reaction analyses (QRAs) were briefed to the US Army's DCSOPS and the Joint Staff on 21 August, a scant 9 days after beginning the effort. Over 500 CEM simulations had been completed by 24 February, the commencement of the ground war. Analysis results were briefed to DCSOPS, the Joint Staff, Army Central Command (ARCENT), Commander in Chief, Forces Command (CINC FORSCOM), the Vice Chief of Staff of the Army (VCSA), and Director, Information Systems - Command, Control, Communications, and Computers (DISC4) with selected results forwarded to Central Command (CENTCOM) in Saudi Arabia.

1-3. CONCEPTS EVALUATION MODEL. The origins of the Concepts Evaluation Model (CEM) date to 1968, when the Research Analysis Corporation initiated development of the Theater Combat Force Requirements Model (TCM) with the capability of determining theater force combat capabilities and requirements. The Army project Conceptual Design for the Army in the Field (CONAF) required a model with TCM's characteristics, and CEM I, a modification of TCM, was born. CEM has gone through many transitions, the most significant being CEM V, the 1978 improvement which modified the model to simulate the new European theater defense concepts. CEM VI, used to model Operation Desert Storm, incorporates an Attrition Model Using Calibrated Parameters (ATCAL) which replaced an earlier attrition process that relied on the questionable method of using indices of firepower potential (CEM VI, Vol I, 1987). CEM has been used at the US Army's Concepts Analysis Agency (CAA) since 1974 in numerous studies to evaluate theater force capabilities and requirements.

1-4. AIRLAND BATTLE-FUTURE. AirLand Battle-Future (also called AirLand Warfare and AirLand Operations in TRADOC draft manuals), is emerging doctrine that will replace AirLand Battle as the Army's strategic and warfighting concept for the 1990s. Although not yet incorporated into Field Manual (FM) 100-5 (Operations), AirLand Battle-Future emphasizes the nonlinear battlefield and breaks combat operations into four specific stages. First is the detection/preparation stage, which concentrates on intelligence preparation of the battlefield (IPB) with the goals to locate and verify enemy positions and provide security for the combat force. Stage II establishes the conditions necessary for decisive operations. Much like current AirLand Battle doctrine's deep attack, Stage II involves using long-range fires of tactical air, multiple launch rocket systems (MLRS), and attack helicopters "to reduce the enemy's numbers, separate him in time and space, and set the conditions for maneuver by tactical units." Next is decisive operations. This stage's highly synchronized battle is focused on the destruction of the enemy. The last stage is reconstitution. Units redisperse, refit, and prepare for future operations (Foss, 1991).

While these four stages differ from the AirLand Battle cornerstones of agility, initiative, depth, and synchronization, it is not a significant departure from them. Indeed, a recent US Army Training and Doctrine Command (TRADOC) document states that current AirLand Battle doctrine "is so well founded that it requires only additional focus to remain vital in the 90s and beyond" (AirLand Warfare, 1990). Just as AirLand Battle-Future expands upon current doctrine, so should our analytical efforts focus on expanding and modifying current tools available.

1-5. BACK TO THE FUTURE - HISTORY AND NONLINEARITY. According to AirLand Battle-Future doctrine, the condition that makes a battlefield nonlinear is the large gaps between forces (Foss, 1991). But nonlinearity is not unique to AirLand Battle-Future. History is replete with examples of this aspect of nonlinearity in both the tactical and strategic sense. Employment of Swiss squares at Laupen in 1339 in cooperating, self-contained units (Jones, 1987) was not linear. The World War I Battle for Lodz saw the Russians and Germans fight in a clearly nonlinear battle (Ludvigsen, 1991). The US Army in Vietnam did not hold a forward edge of battle area (FEBA) in a strategic sense, grouping forces in small fire bases with many gaps between. Thus, AirLand Battle-Future's battlefield gaps has deep seated roots in history.

However, the differences between a linear (or one-dimensional) and a nonlinear battlefield are more than just gaps between forces. The AirLand Battle tenet of depth has long been the second battlefield dimension, eclipsing the one-dimensional linear engagements at the FEBA. Attacking the enemy in depth directly and indirectly affects the close in battle. Deep attacks directly affect the battle by destruction of follow-on forces. Deep attacks indirectly affect the battle by denying the enemy the use of assembly areas, logistics points and airfields and attriting combat support (CS) and combat service support (CSS) assets.

Deep attack also affects a third dimension--the dimension of time, as those follow-on forces and supplies not destroyed are delayed from arrival at the FEBA. Achievement of air superiority denies the enemy freedom of movement, affecting movement schedules of reinforcing units and supplies. battlefield air interdiction (BAI) causes delays by destroying bridges, engaging lines of communication, and laying of area denial munitions. Ground and sea-launched systems also deliver area denial munitions such as the family of scatterable mines (FASCAM) which serve to delay and disrupt enemy movement.

Nonlinearity is not a new battlefield concept, nor is it a new concept to combat simulators. CAA recognized Southwest Asia as a nonlinear (by the AirLand Battle-Future definition) theater of operations in the early 1980s while modeling US contingencies in Iran. Iran's size and rugged terrain dictated the use of groups of forces operating with large gaps between units. Combat simulations for this theater were completed using the CEM. As the Persian Gulf situation developed in August 1990, it was apparent the battle in the Kuwait Theater of Operations (KTO) would also be nonlinear. Again, CEM was used to conduct the necessary simulations. Many innovative concepts were explored to more accurately reflect ground combat in the KTO. However, no coding changes were made to the CEM model. Through Operation Desert Storm, CAA proved CEM's capability to model AirLand Battle and emerging AirLand Battle-Future doctrine.

CHAPTER 2

METHODOLOGIES

2-1. PREFACE

To foster an appreciation for the challenges AirLand Battle-Future doctrine presents the combat modeler, each paragraph contains a brief description of the AirLand Battle Future stage, followed by the modeling aspects of that stage that were addressed in CEM and facilitated by examples from the Desert Storm simulations.

2-2. STAGE I - DETECTION-PREPARATION

The first stage of AirLand Battle-Future is Detection-Preparation. The purpose of this continuous, detailed intelligence preparation of the battlefield is to verify enemy formations and targets (Foss, 1991). Some theater-level models roughly model an intelligence collection process, while others rely on perfect intelligence (WSEG Report 299, 1976). For CEM's automated decisionmaking process, the intelligence capability of engaged forces is simulated by providing an approximation of opposing forces in a given sector over time mitigated by the intelligence capability of the force. The effect of this procedure is that the automated force commander chooses a course of action based on the known strengths of the force that had opposed his sector in the preceding two cycles. Additionally, the Blue force commander may be allowed an improved capability, which uses opposing force strengths of the current and preceding cycle (CEM VI Vol I, 1987). However, the first stage of AirLand Battle-Future begins well before two opposing forces actually engage. Here, as in all simulations, the initial concept of the operation is decided by those requesting the simulation.

In Desert Storm, the multitude of highly technical national resources used throughout the campaign provided the capability of near-real time, accurate battlefield intelligence. The effect on CAA's Desert Storm analyses was tremendous. While having little impact on the intelligence portion of the CEM model, CAA's access to such intelligence enabled frequent, often daily updates of the opposing forces files. This data enabled timely evaluation of enemy capabilities made possible by the introduction of these new forces. In turn, this allowed CAA to provide to the DCSOPS simulation results of a new threat's impact in about 12 hours.

2-3. STAGE II - CONDITIONS FOR DECISIVE OPERATIONS

The second stage of AirLand Battle-Future establishes conditions for decisive operations. This consists of concentrating artillery (MLRS and ATACMS), attack helicopters, and tactical aircraft with the objective of reducing the enemy's numbers, separating him in time and space and setting the conditions for maneuver by tactical units (Foss, 1991). CEM capabilities permitted three different methods of modeling the attack of the enemy with fire support assets in Operation Desert Storm simulations.

Initially, special attrition factors developed to model tactical air effects on the Iraqi divisions were used for Desert Storm simulations. A CEM

simulation would be run for the period that tactical air would be employed prior to commencement of ground operations. Because of the special factors, no ground-to-ground combat would take place during this "air only" run. End strength of the air-attrited divisions was then applied to CEM input files, and another simulation run, this time with the standard attrition factors, was completed.

A similar procedure was used interfacing with the TacThunder model. The Air Force's Center for Studies and Analysis would complete a TacThunder simulation and provide CAA with remaining strength and equipment of Iraqi divisions attacked by air. As above, this data would be applied to CEM input files, and a CEM simulation would then be conducted.

Both the methods described above were technically valid, but only provided a single level of contribution that air could make to the attrition of Iraqi ground forces. At that time (October-November 1990), estimates of the impact of an air war on the Iraqi ground forces from senior military analysts varied wildly. Some said that the war could be won by air alone. Others predicted that heavily dug-in troops would be largely unaffected by air attack, regardless of duration or intensity, and a bloody ground war lay ahead. CAA decided to conduct simulations parametrically, applying two, three, and ultimately four levels of air attrition to Iraqi divisions. Although this necessitated multiple simulation runs, refinement of the simulation process through 8 weeks of around-the-clock operations enabled CAA to maintain a 12-hour response time from tasking by the sponsor to delivery of the final product. Results gave the decisionmakers a ground forces performance window based on the varied effects of air.

2-4. STAGE III - DECISIVE OPERATIONS

The third stage of AirLand Battle-Future is the decisive operations stage. This is the actual engagement of opposing ground forces. It is important to note the AirLand Battle-Future description of how a corps might operate on the nonlinear battlefield: "The corps will operate in time and three-dimensional space, but will focus on enemy and not terrain" (AirLand Warfare, 1990). The challenges for combat simulators inherent in Stage III are modeling gaps between forces, the effects of time, and destruction of the enemy.

a. Nonlinear Battlefield

Perhaps the biggest challenge of this stage is modeling the gaps between forces. The modification made to CEM in the early 1980s for the first Southwest Asia contingency permits the use of a disjointed, or discontinuous FEBA. With the discontinuous FEBA feature activated in CEM, the flanking rules for divisions are ignored for the division's flank which coincides with an army boundary. In effect, this allows each army to operate independent of the other's performance. Shown in Figure 2-1 is what the FEBA might look like for the same scenario played with the two different FEBA options. On the right, the performance of each army can be easily discerned. On the left, the flanking rules mitigate the individual performances of the armies.

The exclusion of army flanking rules also provides terrain flexibility, an important aspect of nonlinear warfare. Since the army boundaries in CEM are fixed, releasing army flanking rules also implies a release of the obligation to maintain any terrain integrity across army boundaries. As Figure 2.2 shows, a continuous FEBA implies that the terrain the linked armies will traverse must also be continuous. Conversely, the disjointed FEBA allows great flexibility in choosing the separate terrain corridors for each army. Armies might be separated by 1 kilometer or 100, earth or ocean, depending on what the concept of operation requires. Terrain can vary greatly from one army corridor to the next; note the amphibious operation on the right-hand illustration in Figure 2-2.

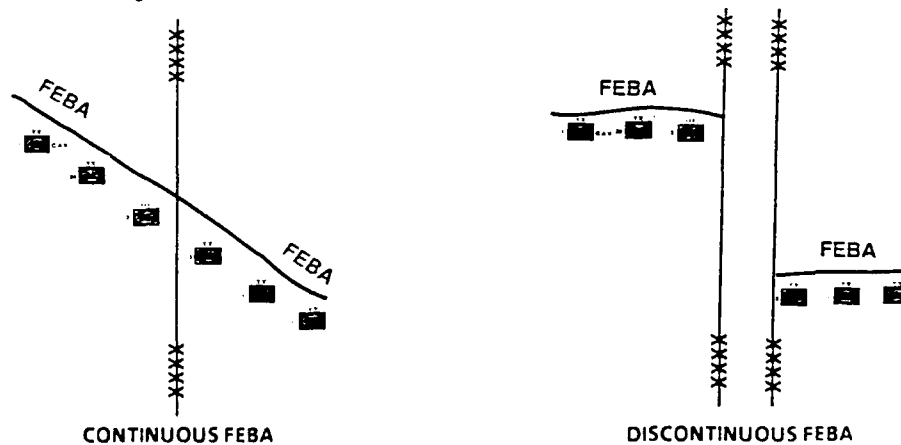


Figure 2-1. Flanking Rules

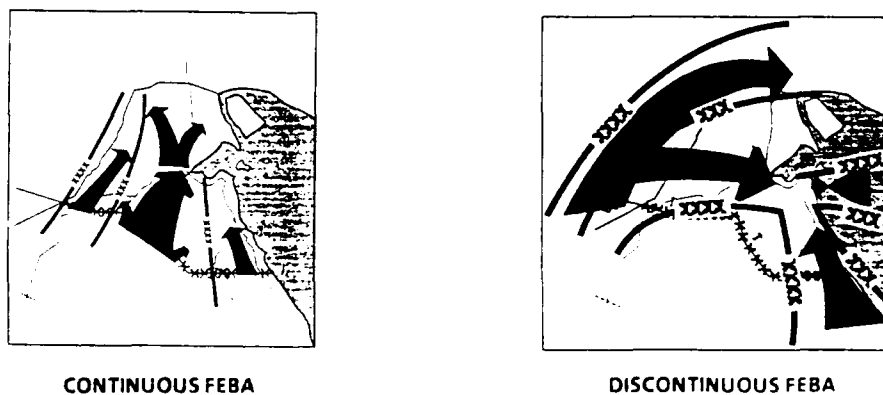


Figure 2-2. Terrain Flexibility

b. The Dimension of Time and the Concept of the Operation

The dimension of time was critical in shaping the ground combat of Desert Storm. The Desert Storm concept of operation included US Marine Corps Central Command forces (MARCENT) and Arab coalition forces initiating the ground attack through Kuwait as two augmented US Army corps formed to the west, awaiting commitment. Marine amphibious forces off the Kuwaiti coast waited, prepared to respond if required. Timing of the enemy's response was also a critical and difficult aspect to consider in the development of the

concept of the operation. Which Iraqi units would engage the different coalition thrusts, and when, were critical elements of information or planning purposes. The modeling challenges in CEM were to simulate the application of initial forces staggered by time, and decide as a function of time which Iraqi forces would be the opponents of each individual coalition thrust northward.

c. Staggering the Attack

Operational considerations for timing became a critical part of modeling Desert Storm as many concepts of operation called for different forces to begin the battle at different times, sometimes days apart. Amphibious assault scenarios called for assaults to begin several days after campaign commencement (D-day) to ensure successful linkup opportunities. One CEM modeling challenge was to begin a battle in a given sector after D-day. CEM requires each portion of the battlefield to be occupied on D-day as the campaign begins. Staggering the ground attack used the same innovation initially developed to simulate an amphibious assault, described in the following paragraph.

d. Amphibious Operations

Modeling Desert Storm amphibious assaults in CEM was the first use of the arrival feature of CEM to permit delays in the commitment of initial forces to the battlefield. CEM has the capability to commit arriving forces to the battle, based on European concepts of defense. European scenarios called for a forward defense conducted by forces garrisoned in Europe while contingency forces mobilized and deployed, arriving on the battlefield well after commencement of hostilities. This feature required that the battlefield sector where arriving units would be committed be initially occupied by the forward-deployed forces. Conversely, execution of an amphibious landing required battlefield sectors be essentially unoccupied until beginning the amphibious assault. A "dummy," or notional division with no assigned equipment, was used to facilitate this. Dummy divisions occupied the necessary sectors of the FEBA at the beginning of the simulation, so actual forces could be committed at some later time, say D+5. Later, this technique was used to model the delay of the VII and XVIII Corps as they attacked after the initial MARCENT and Arab coalition thrusts into Kuwait.

e. Arraying the Defense

For Desert Storm simulations, each US Army corps, the non-US coalition forces (minus the British and French), and MARCENT fought in battlefield sectors separated by gaps. British and French forces were attached to one or more of the above elements as the scenario dictated. A continual modeling challenge with this discontinuous battlefield was choosing opposing forces for each battlefield sector. The dimension of time became very important in this effort when attempting to link expectations of enemy reactions with when and where each Iraqi division would engage advancing coalition forces.

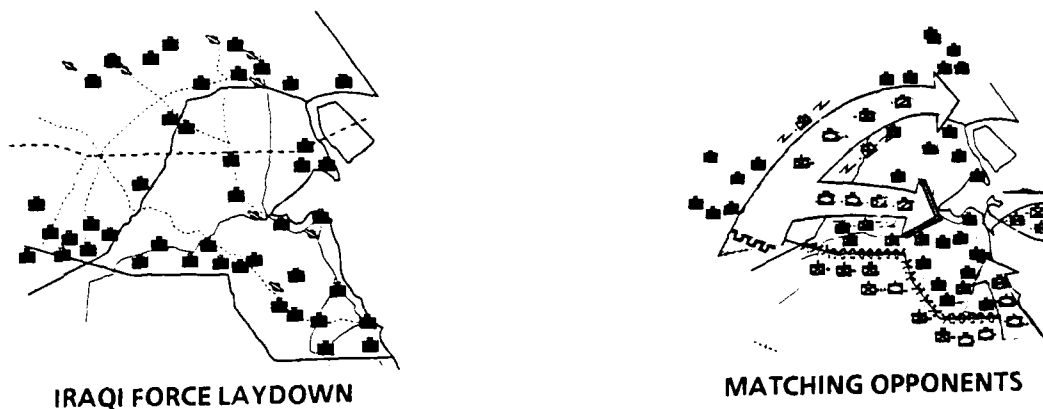


Figure 2-3. Arraying the Defense

f. Enemy Courses of Action

Perhaps the most important example of the use of time in the modeling of Desert Storm occurred in our attempts to anticipate the reaction of the Republican Guards to the commencement of the ground campaign. Two basic scenarios were that either the Republican Guards would defend Basra, or they would move to counterattack coalition forces. These were modeled using the element of time. If the Republican Guards chose to defend, the coalition forces would meet them at a later time in the battle than if the Republican Guards moved to meet coalition forces in a counterattack.

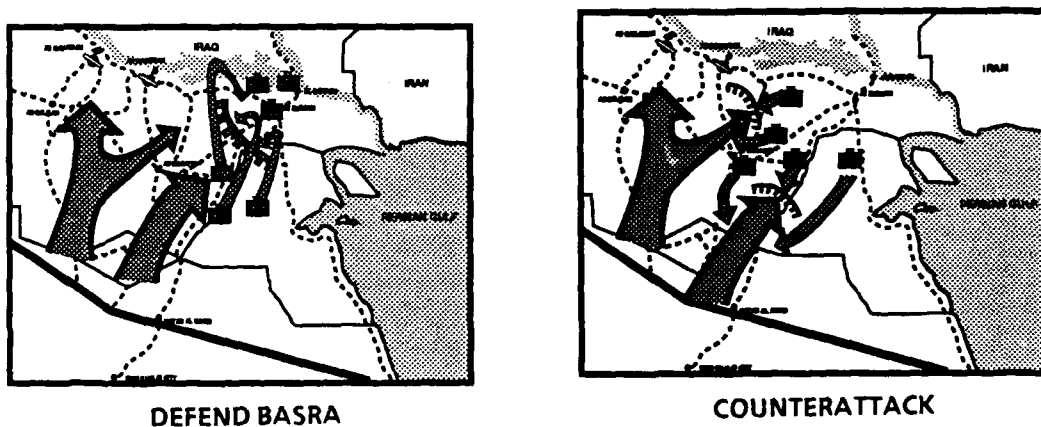
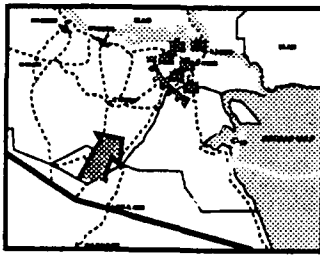
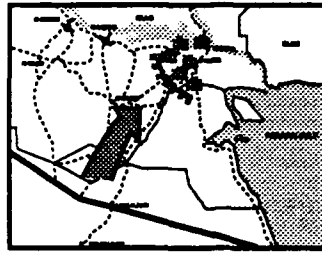


Figure 2-4. Republican Guards Courses of Action

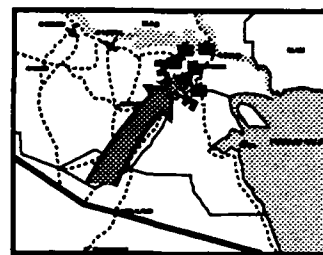
Some simulations required reruns with adjusted arrival schedules to compensate for unexpected rates of advance. For example, the defense of Basra required the Republican Guards to be "arrived" onto the battlefield at the time the coalition forces reached Basra. If in the initial run the coalition forces reached Basra either earlier or later, a rerun would be necessary to synchronize the arrival time of the Republican Guards to match the time coalition forces reached Basra.



US ATTACKS
(D + 1)



US ADVANCES
(D + 3)



GUARDS ENGAGED
(D + 5)

Figure 2-5. Republican Guards "Arrived" at D+5 as Coalition Forces Reach Basra

g. Destroying the Force

The goal of the battle in AirLand Battle-Future is the destruction of the enemy. One of the key goals in Operation Desert Storm was the destruction of the Republican Guards. As scenarios were run in CEM, the end of the battle was measured by various means. Early on, it was measured by terrain objectives, e.g., the restoration of the Kuwait-Iraq border. As policy shifted and it became apparent that Iraqi military capability must be destroyed, the measure of the end of the battle in CEM became the loss exchange and force exchange ratios. The loss exchange ratio (LER) is simply the ratio of Red major systems lost to Blue major systems lost.

$$\text{LER} = \text{Red Systems Lost} / \text{Blue Systems Lost}$$

The force exchange ratio is the ratio of the percentage of Red combat worth lost to the percentage of Blue combat worth lost, where combat worth is the ratio of systems lost to systems onhand.

$$\text{FER} = \text{Red Combat Worth Lost (\%)} / \text{Blue Combat Worth Lost (\%)}$$

$$\text{where } \text{Combat Worth Lost (\%)} = \text{Systems Lost} / \text{Systems Onhand}$$

The FER provides the most accurate picture of force capability as it relates systems losses to remaining combat power. Loss of 1 tank out of 4,000 is not significant; loss of 1 tank out of 3 is. In the later Desert Storm simulations, the battle was terminated when the FER began to balloon and the Republican Guards began losing the major portion of its combat power.

2-5. STAGE IV - RECONSTITUTION

The final stage, reconstitution, is addressed by AirLand Battle-Future as a postscript to the battle: "The concept does not consider it routinely necessary to execute CSS reconstitution operations for maneuver forces during the execution of the tactical mission..." (AirLand Warfare, 1990). Although the differentiation between CSS reconstitution operations and routine CSS operations is not made in the draft text of AirLand Warfare, it would be worthwhile to address reconstitution in terms of specific types of support that can await battle completion before replenishment. Certainly during Operation Desert Storm there were continual demands for fuel and potable water during the 100 hours of ground combat. Accounts of the logistics train that accompanied the 24th Infantry Division (Mechanized) make it clear that organic CSS elements were heavily supplemented by corps-level CSS units for the relatively short duration of ground combat. (Galloway, 1991) Desert Storm should leave no doubt that logistics concerns must be addressed as an ongoing process that is an integral part of every phase of an operation.

Although CEM does not explicitly play elements of CS and CSS on the CEM battlefield (there is no way to destroy supply nodes or bases), many logistics functions are modeled in CEM; specifically maintenance, ammunition consumption, and petroleum, oils, and lubricants (POL). Damaged vehicles are returned after a specified time for repair, or may wait to be repaired if demand exceeds available repair capability. Class III, V, and VII resupply can be arrived over time in theater, and resupply can be delayed, depending upon the degree of air superiority achieved.

CEM logistical insights were used in much of the planning for Operation Desert Storm. CEM output detailing ammunition consumed, permanent losses of Class VII combat equipment, and personnel losses was used directly in Desert Storm planning. Output from CEM was used to initialize the Force Analysis Simulation of Theater Administrative and Logistic Support (FASTALS) Model which rounds out the combat force with the appropriate complement of CS and CSS units such as truck, water, and POL supply companies. Although CEM has not been known for providing high resolution logistical details, the information it did provide was of substantial value in combat support force sizing and below the line Time-Phased Force Deployment Data (TPFDD) development.

CHAPTER 3

CONCLUSIONS

Operation Desert Storm has provided unique opportunities for examining our doctrine both on the battlefield and in the analytical community. Many AirLand Battle-Future tenets got an early test in Kuwait and Iraq. CAA's capability to provide extremely responsive, yet detailed, campaign simulation analyses to key planners and decisionmakers reinforces the need for the analytical community to have a viable combat simulation capability for the 1990s. Using CEM as the primary analytical tool, it was discovered that AirLand Battle-Future simulations did not require new models with extraordinary capabilities. This revelation takes on a new importance when looking at the "big picture." The shrinking defense budget may impact severely on the analytical community, affecting such key resources such as personnel, funding, and, with fewer people to do the same amount of work, time. These three resources are the very ones that are the most critical when considering development and implementation of new models. Simulating AirLand Battle-Future will require new approaches and concepts, but these can be applied to existing models, with perhaps some minor modifications in the model itself. With the ample talents of the analytical community, this is a challenge that can and must be achieved.

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